Carbon Sequestration Newsletter

August 2011

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Introduction

This Newsletter is created by the National Energy Technology Laboratory and represents a summary of carbon sequestration news covering the past month. Readers are referred to the actual article(s) for complete information. It is produced by the National Energy Technology Laboratory to provide information on recent activities and publications related to carbon sequestration. It covers domestic, international, public sector, and private sector news.

Highlights

***NETL News Release*, "Projects Aimed at Advancing State-of-the-Art Carbon Capture from Coal Power Plants Selected for Further Development."**

On August 15, 2011, the U.S. Department of Energy's (DOE) Office of Fossil Energy (FE) selected four projects aimed at reducing the energy and cost penalties of advanced carbon capture systems applied to power plants for further development. The projects are valued at approximately $67 million (including $15 million in non-Federal cost sharing) over four years. The overall goal of the research is to develop carbon dioxide (CO_2) capture and separation technologies that can achieve at least 90 percent CO_2 removal at no more than a 35 percent increase in the cost of electricity. The projects, managed by FE's National Energy Technology Laboratory (NETL), include: (1) Linde, LLC, which will use a post-combustion capture technology incorporating BASF's novel amine-based process at a 1-megawatt electric (MWe) equivalent slipstream pilot plant at the National Carbon Capture Center (NCCC) (DOE contribution: $15 million); (2) Neumann Systems Group, Inc., which will design, construct, and test a patented NeuStreamTM absorber at the Colorado Springs Drake #7 power plant (DOE contribution: $7,165,423); (3) Southern Company, which will develop viable heat integration methods for the capture of CO_2 produced from pulverized coal (PC) combustion using a waste heat recovery technology (DOE contribution: $15 million); and (4) the University of Kentucky Research Foundation, which plans to use an innovative heat integration method that uses waste heat from a Hitachi H3-1 advanced solvent carbon capture system while improving steam turbine efficiency (DOE contribution: $14,502,144). August 15, 2011, http://www.netl.doe.gov/publications/press/2011/110815_projects_aimed_at_advancing%20.html.

Sequestration in the News

***Thunderbird Energy News Release*, "Carbon Storage Project at Thunderbird Energy's Gordon Creek Natural Gas Field Moving Forward with Operations."**

Thunderbird Energy announced that the Southwest Regional Partnership on Carbon Sequestration's (SWP) Deployment Phase (Phase III) CO_2 storage project is moving forward with field operations at a natural gas field. SWP, one of DOE's seven Regional Carbon Sequestration Partnerships (RCSPs), will site the project at Thunderbird's Gordon Creek natural gas project located in Carbon County, Utah. The initial phase of field operations will include an extensive 3-D seismic shoot and the drilling of up to two, 12,000-foot deep CO_2 source wells to establish the potential size of the known CO_2 resource at Gordon Creek, thereby securing a long-term supply of CO_2. In addition, the field operations will include drilling and/or re-completing monitoring wells; upgrading Thunderbird's existing injection facility, constructing roads, pipeline, and surface facilities; and conducting ongoing supervisory and monitoring operations. RCSP Development Phase efforts are

National Energy
Technology Laboratory

626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940

3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880

13131 Dairy Ashford Road, Suite 225
Sugar Land, TX 77478

1450 Queen Avenue SW
Albany, OR 97321-2198

2175 University Ave. South, Suite 201
Fairbanks, AK 99709

John T. Litynski
412-386-4922
john.litynski@netl.doe.gov

Dawn M. Deel
304-285-4133
dawn.deel@netl.doe.gov

Visit the NETL website at:
www.netl.doe.gov

Customer Service:
1-800-553-7681

Sequestration in the News (Continued)

intended to demonstrate proof-of-concept technologies for the potential commercialization of CO_2 storage with a project objective of safely storing up to 1 million tons of CO_2 per year. More information on SWP is available at: http://southwestcarbonpartnership.org/. August 11, 2011, http://www.marketwire.com/press-release/carbon-storage-project-thunderbird-energys-gordon-creek-natural-gas-field-moving-forward-tsx-venture-tbd-1548655.htm.

***Reuters*, "Montana Launches $85 Million Carbon Storage Project,"** and ***Montana State University News Release*, "MSU Moves Forward with U.S. Department of Energy Backed Carbon Dioxide Storage Project in Northern Montana."**

DOE has approved a pilot project headed by Montana State University that will involve permitting, injecting, and monitoring 1 million tons of CO_2 into a deep porous rock formation in northern Montana. The goal of the project, which will be carried out by DOE's Big Sky Carbon Sequestration Partnership (BSCSP), is to determine whether CO_2 emissions can be captured and safely stored in regional geologic formations. The project site will be located at Kevin Dome, a subterranean rock formation in the north-central part of Montana that stretches for 700 square miles and has been capturing naturally occurring CO_2 for millions of years. The CO_2 will be injected into a rock layer that has not been previously exposed to CO_2, allowing scientists to study the reaction between rocks that have been previously exposed to CO_2 and those that have not. Development of the site, including the drilling of injection wells, is expected to begin immediately, with storage planned to begin in two years. According to scientists, the site has the potential to store as much as 1 billion tons of CO_2. For more information on the Kevin Dome Large-Scale Storage Project, visit the BSCSP website at: http://www.bigskyco2.org/research/geologic/kevinstorage. July 26, 2011, http://www.reuters.com/article/2011/07/27/us-carbon-montana-idUSTRE76Q0AI20110727, and July 26, 2011, http://www.montana.edu/cpa/news/nwview.php?article=10021.

***Battelle News Release*, "Battelle Successfully Completes Carbon Storage Project Benefiting Industry in Ohio Valley Energy Corridor."**

Battelle and American Electric Power (AEP) have completed a small-scale carbon capture and storage (CCS) test at a coal-fired power plant at AEP's Mountaineer Power Plant in New Haven, West Virginia. The project began in 2003 with funding from DOE, the state of Ohio, and other sources to study the region's geology and determine the merits of CO_2 storage in the area. In 2007, AEP deployed a 20-megawatt (MW) pilot-scale CCS system at Mountaineer Power Plant. The project became operational in 2009, marking one of the first instances that CO_2 capture, transport, injection, storage, and monitoring were all in operation at a coal-fired power plant. July 21, 2011, http://battelle.org/SPOTLIGHT/7-21-11_carbon.aspx.

Sequestration in the News (Continued)

***Government of Alberta News Release*, "Clean Energy Project Agreement in Place,"** and ***St. Albert Gazette*, "Province Invests $285 Million in Carbon Capture."**

The Government of Alberta and Swan Hills Synfuels have signed a final funding agreement for a CCS project that will capture 1.3 million tonnes of CO_2 annually from a coal gasification process and store it underground for enhanced oil recovery (EOR). The coal gasification process will tap into an unmineable coal area near Swan Hills and turn the coal into a syngas. In total, the project is expected to cost $1.5 billion; the Government of Alberta has committed $285 million to the project, providing 40 percent initially, 20 percent after commercial start-up, and the remaining 40 percent over the next 15 years. Construction is expected to begin in 2013, with carbon capture beginning in late 2015. July 27, 2011, http://alberta.ca/home/NewsFrame.cfm?ReleaseID=/acn/201107/309936C704039-C791-2E11-450AA4194BD5C4C0.html, and July 30, 2011, http://www.stalbertgazette.com/article/20110730/SAG0801/307309978/province-invests-285-million-in-carbon-capture.

Announcements

DOE's Carbon Storage Program Infrastructure Annual Review Meeting.

DOE's 2011 Annual Review Meeting, featuring the RCSPs, will be held at the Sheraton Station Square Hotel in Pittsburgh, Pennsylvania, on November 15-17, 2011. This meeting highlights DOE's carbon storage infrastructure projects, which include the efforts of DOE's RCSPs; however, it is now expanding to include other U.S. and international projects that are working to characterize CO_2 storage capacity through exploration and injection operations. An interactive reception and poster sessions will be held to highlight geologic CO_2 storage and characterization work being performed by the American Recovery and Reinvestment Act (ARRA)-supported Regional Carbon Sequestration Training Centers, DOE's National Laboratories, RCSP subcontractors, and other organizations. For more information, go to: http://www.netl.doe.gov/events/.

NATCARB Viewer Available.

An updated and redesigned version of the National Carbon Sequestration Database and Geographic Information System (NATCARB) was launched on the NETL website. The interactive online tool integrates a wealth of information about worldwide efforts to deploy CCS technologies. The tabs within NATCARB open different maps for query and analysis capabilities, including an (1) RCSP tab; (2) ATLAS tab; (3) FIELD PROJECTS tab; and (4) WCCS tab. The NATCARB Viewer is accessible from: http://www.netl.doe.gov/technologies/carbon_seq/natcarb/index.html.

CCS Workshop.

The International Petroleum Industry Environmental Conservation Association (IPIECA) is hosting a workshop, titled, "Carbon capture and storage: Addressing the remaining knowledge gaps," at the Four Points Sheraton in Washington, DC, on September 20-21, 2011. Discussion will focus on knowledge gaps and barriers to CCS, including potential future demonstration projects that would contribute to technology advancement. For more information, as well as a downloadable workshop program, go to: http://www.ipieca.org/event/20110506/addressing-remaining-gaps-knowledge-ccs.

CCS Public Outreach and Education.

The Wyoming Carbon Capture and Storage Technology Institute (WCTI), an organization that develops CCS education and training courses with the University of Wyoming, is offering a new, online class, titled, "CCS Public Outreach and Education." The primary objective of the course is to help professionals in the CCS industry understand and apply effective public education and outreach strategies in selecting, permitting, and operating a carbon storage site. For more information, as well as a list of all available WCTI courses, visit: http://www.wyomingcarbonstorage.com/courses.

Norway, Germany Establish Power, Carbon Capture Working Groups.

Norway and Germany announced an agreement to establish energy working groups to explore cooperation on CCS and power market trading balancing capacity. According to the joint statement released by the Norwegian Energy and Oil Ministry and the Germany Economics and Technology Ministry, the groups will share knowledge on CCS and promote cross-border electricity trade. To learn more, visit: http://www.bloomberg.com/news/2011-08-03/norway-germany-establish-power-carbon-capture-working-groups.html.

Science

***National Oceanic and Atmospheric Administration Press Release*, "NOAA Scientists Link Shifting Atlantic Mackerel Distribution to Environmental Factors, Climate Change."**

Scientists from the National Oceanic and Atmospheric Administration (NOAA) have discovered that the distribution patterns of Atlantic mackerel have possibly changed due to potential climate change. Atlantic mackerel, found in waters from Cape Hatteras to Newfoundland, migrate on a seasonal basis to feed and spawn. However, the mackerel are sensitive to changing water temperatures and shifted northeastward into shallower waters, potentially impacting U.S. commercial and recreational fisheries. Using spatial data, researchers from NOAA's Northeast Fisheries Science Center (NEFSC) studied annual changes in the winter and early-spring distribution of the Atlantic mackerel stock on the northeast U.S. continental shelf. They found that the overwintering distribution of the Northwest Atlantic stock shifted approximately 155 miles north and 30 miles east from 1968 to 2008, also shifting from deep, off-shelf locations to more shallow, on-shelf areas that have more water within their preferred temperature range, which is above 5°C. The shift could pose a challenge to U.S. commercial vessels looking to locate Atlantic mackerel during the winter months, because the fish are dispersed over a larger area of water. August 11, 2011, http://www.nefsc.noaa.gov/press_release/2011/SciSpot/SS1104/.

***Science Daily*, "Climate Change Could Drive Native Fish out of Wisconsin Waters."**

According to a report published in the online journal "Public Library of Science One," the cisco, a fish found in Wisconsin's deepest and coldest bodies of water, could be driven out of local waters due to potential climate change. Researchers from the University of Wisconsin-Madison and the Wisconsin Department of Natural Resources ran several possible future climate scenarios that led to their prediction that the cisco, found in approximately 170 inland lakes in Wisconsin, could disappear from the majority of the state's lakes due to warmer waters. The cisco is an important food for many of Wisconsin's game species. August 16, 2011, http://www.sciencedaily.com/releases/2011/08/110816112115.htm.

Policy

***SustainableBusiness.com*, "ISO Releases Greenhouse Gas Verification Standard."**

The International Organization for Standardization (ISO) has released a new standard for achieving consistency in the global carbon market and maintaining public confidence in greenhouse gas (GHG) reporting. ISO 14066, which provides guidance on the level of competency required by individuals responsible for verifying GHG emissions, lays out lists of the skills and knowledge that must be possessed by the auditing team. ISO 14066 is the latest of a three-part standard for assessing potential climate change and GHG emissions; these were launched in 2006 with ISO 14064, which focused on assessing GHG emission reduction projects in either voluntary or regulatory schemes. ISO 14065 followed, giving accreditation requirements for organizations that validate or verify resulting GHG emission claims. August 2, 2011, http://www.sustainablebusiness.com/index.cfm/go/news.display/id/22726.

***U.S. EPA News Release*, "EPA Takes Action on Reducing Barriers to the Use of Carbon Capture and Sequestration Technologies."**

The U.S. Environmental Protection Agency (EPA) is proposing a rule to advance the use of CCS technologies while protecting the health and safety of the public and the environment. Under the proposal, CO_2 streams that are injected for geologic storage in wells designated for this purpose under the Safe Drinking Water Act (SDWA) will be excluded from EPA's hazardous waste regulations in an effort to reduce barriers to the use of CCS technologies. According to EPA's review of existing regulatory programs, this proposal concludes that the management of CO_2 streams under the proposed conditions does not present a substantial risk to people's health or to the environment; provides regulatory certainty to industries considering the use of CCS technologies; and encourages the deployment of CCS technologies in a safe, environmentally protective manner. EPA will accept public comments on the proposal for 60 days following publication in the Federal Register. For more information on the proposed rule, visit: http://www.epa.gov/epawaste/nonhaz/industrial/geo-sequester/index.htm. August 4, 2011, http://yosemite.epa.gov/opa/admpress.nsf/1e5ab1124055f3b28525781f0042ed40/fde8d083af16268e852578e10080f49b!OpenDocument.

"Development of a scalable infrastructure model for planning electricity generation and CO_2 mitigation strategies under mandated reduction of GHG emission."

The following is the Abstract of this article: "In a power-generation system, power plants as major CO_2 sources may be widely separated, so they must be connected into a comprehensive network to manage both electricity and CO_2 simultaneously and efficiently. In this study, a scalable infrastructure model is developed for planning electricity generation and CO_2 mitigation (EGCM) strategies under the mandated reduction of GHG emission. The EGCM infrastructure model is applied to case studies of Korean energy and CO_2 scenarios in 2020; these cases consider combinations of prices of carbon credit and total electricity demand fulfilled by combustion power plants. The results highlight the importance of systematic planning for a scalable infrastructure by examining the sensitivity of the EGCM infrastructure. The results will be useful both to help decision makers establish a power-generation plan, and to identify appropriate strategies to respond to climate change." **Jee-Hoon Han and In-Beum Lee**, *Applied Energy*, Available online August 3, 2011, doi:10.1016/j.apenergy.2011.07.010, http://www.sciencedirect.com/science/article/pii/S0306261911004557. (Subscription may be required.)

Geology

"Supercritical carbon dioxide and sulfur in the Madison Limestone: A natural analog in southwest Wyoming for geologic carbon–sulfur co-sequestration."

The following is the Abstract of this article: "The Madison Limestone on the Moxa Arch, southwest Wyoming, USA, contains large volumes (65-95 [percent]) of supercritical CO_2 that it has stored naturally for 50 million years. This reservoir also contains supercritical [hydrogen sulfide (H_2S)], aqueous sulfur complexes (SO_4^{2-} and HS^-), and sulfur-bearing minerals (anhydrite and pyrite). Although [sulfur dioxide (SO_2)] is not present, these sulfur-bearing phases are known products of SO_2 disproportionation in other water–rock systems. The natural co-occurrence of SO_4^{2-}, S^{2-}, supercritical CO_2 and brine affords the opportunity to evaluate the fate of a carbon–sulfur co-sequestration scenario. Mineralogic data was obtained from drill core and aqueous geochemical data from wells outside and within the current supercritical CO_2–sulfur–brine–rock system. In addition to dolomite, calcite, and accessory sulfur-bearing minerals, the Madison Limestone contains accessory quartz and the aluminum-bearing minerals feldspar, illite, and analcime. Dawsonite ($NaAlCO_3(OH)_2$), predicted as an important carbon sink in sequestration modeling studies, is not present. After confirming equilibrium conditions for the Madison Limestone system, reaction path models were constructed with initial conditions based on data from outside the reservoir. Addition of supercritical CO_2 to the Madison Limestone was simulated and the results compared to data from inside the reservoir. The model accurately predicts the observed mineralogy and captures the fundamental changes expected in a Madison Limestone-brine system into which CO_2 is added. The pH decreases from 5.7 to 4.5 at 90°C and to 4.0 at 110°C, as expected from dissolution of supercritical CO_2, creation of carbonic acid, and buffering by the carbonate rock. The calculated redox potential increases by 0.1 V at 90°C and 0.15 V at 110°C due to equilibrium among CO_2, anhydrite, and pyrite. Final calculated Eh and pH match conditions for the co-existing sulfur phases present in produced waters and core from within the reservoir. Total dissolved solids increase with reaction progress, mostly due to dissolution of calcite with an accompanying increase in dissolved bicarbonate. The Madison Limestone is a natural example of the thermodynamic end point that similar fluid–rock systems will develop following emplacement of a supercritical CO_2–sulfur mixture and is a natural analog for geologic carbon–sulfur co-sequestration." **John P. Kaszuba, Alexis Navarre-Sitchler, Geoffrey Thyne, Curtis Chopping, and Tom Meuzelaar**, *Earth and Planetary Science Letters*, Available online July 20, 2011, doi:10.1016/j.epsl.2011.06.033, http://www.sciencedirect.com/science/article/pii/S0012821X11004043. (Subscription may be required.)

"Dedolomitization as an analogue process for assessing the long-term behavior of a CO_2 deep geological storage: The Alicún de las Torres thermal system (Betic Cordillera, Spain)."

The following is from the Abstract of this article: "The study of natural analogues represents the best source of reliable information about the expected hydrogeochemical processes involved in the CO_2 storage in such deep saline aquifers. In this work, a comprehensive study of the hydrogeochemical features and processes taking place at the natural analogue of the Alicún de las Torres thermal system (Betic Cordillera) has been conducted. Thus, the main water/CO_2/rock interaction processes occurring at the thermal system have been identified, quantified and modeled, and a principle conclusion is that the hydrogeochemical evolution of the thermal system is controlled by a global dedolomitization process triggered by gypsum dissolution. This geochemical process generates a different geochemical environment to that which would result from the exclusive dissolution of carbonates from the deep aquifer, which is generally considered as the direct result of CO_2 injection in a deep carbonate aquifer. Therefore, discounting of the dedolomitization process in any CO_2 deep geological storage may lead to erroneous conclusions. This process will also influence the porosity evolution of the CO_2 storage formation, which is a very relevant parameter when evaluating a reservoir for CO_2 storage. The geothermometric calculation performed in this work leads to estimate that the thermal water reservoir is located between 650 and 800 m depth, which is very close to the minimum required to inject CO_2 in a deep geological storage. It is clear that the proper characterization of the features and hydrogeochemical processes taking place at a natural system analogous to a man-made deep geological storage will provide useful conceptual, semi-quantitative and even quantitative information about the processes and consequences that may occur at the artificial storage system." **Antonio J. Prado-Pérez and Luís Pérez del Villar**, *Chemical Geology*, Available online August 3, 2011, doi:10.1016/j.chemgeo.2011.07.017, http://www.sciencedirect.com/science/article/pii/S0009254111003056. (Subscription may be required.)

"CarbFix: a CCS pilot project imitating and accelerating natural CO_2 sequestration."

The following is the Abstract of this article: "CarbFix, a combined industrial-academic pilot program, was developed in order to assess the feasibility of in situ CO_2 mineral sequestration in basaltic rocks. Unique to CarbFix is its connection to the Hellisheidi geothermal power plant, allowing for capture of otherwise emitted CO_2 in addition to CO_2 transport and mineral sequestration. Extensive research has been conducted in order to characterize physical properties of the pilot injection site in Hellisheidi. Tracer tests have been carried out and continuous well-logging confirmed separation of the target formation from shallower groundwater systems. Alteration mineralogy in natural analogs has been mapped out in order to predict which minerals are likely to precipitate upon CO_2 injection. In addition to carbonates, these include clays, zeolites, and poorly crystalline hydroxides. Some of the secondary minerals will compete with carbonates for cations dissolved from the rock matrix. Numerical modeling plays an important role in the CarbFix project as it provides tools to predict and optimize long-term management of the injection site as well as to quantify the amount of CO_2 that can be mineralized. A reactive transport model has been developed and numerical simulations of the pilot CO_2 injection are ongoing. Extensive monitoring provides the basis for testing, validating, and calibrating reactive transport models. It is anticipated that the results of CarbFix will be used to optimize the in situ carbon mineralization process, enabling it in basalt and ultramafic rock formations throughout the world." **Edda S.P. Aradóttir, Hólmfrídur Sigurdardóttir, Bergur Sigfússon, and Einar Gunnlaugsson**, *Greenhouse Gases: Science and Technology*, Available online May 25, 2011, doi:10.1002/ghg.18, http://onlinelibrary.wiley.com/doi/10.1002/ghg.18/abstract. (Subscription may be required.)

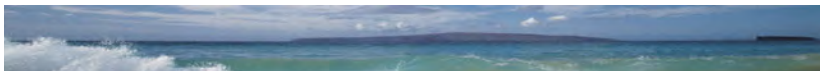
TECHNOLOGY

"A study of methodologies for CO_2 storage capacity estimation of coal."

The following is the Abstract of this article: "[CCS] in unmineable coal seams is regarded as one of the possible approaches to mitigate the ever increasing CO_2 concentration in the atmosphere resulting from human activities since the Industrial Revolution. Injection of CO_2 into unmineable coal seams not only provides a solution for long term storage of CO_2 but it also provides the added advantage of enhancing coalbed methane recovery. Adsorption is the main trapping mechanism for CO_2 storage in coal seams where it constitutes to about 95–98 [percent] of total storage. Other trapping mechanisms include gas trapped within the matrix structure, free gas and CO_2 trapped as a solute in the pore water. Coal is usually highly heterogeneous and contains pores of different sizes: micropores, mesopores, and macropores. The physical properties such as permeability, which usually changes with depth and the degree of cleating, complicates the storage capacity estimation process. Injection of highly dense phase CO_2 may offer higher storage capacity because of its higher density compared to gaseous CO_2. However, there is a lack of verified CO_2 storage capacity estimation methodology for coalbeds. Computing storage potential of CO_2 is not straightforward due to the highly variable coal properties even in the same coal seam. Therefore, in this paper a statistical framework for estimating the CO_2 storage capacity in coal seams is presented with the emphasis on highly dense CO_2 conditions. The approach is based on earlier studies, which utilize important in situ parameters to estimate storage capacity in coal seams. These parameters include volatile matter content, moisture, ash, pressure and temperature. Furthermore, several widely used adsorption models for single- and multi-component gas are reviewed. The ability of the various models in predicting the adsorption capacity for different coal types and under various in situ conditions was examined. Dataset consists of adsorption data representing 69 coal types having vitrinite reflectance ranging from 0.25 [percent] to 3.86 [percent]. Results of analyses of this dataset showed that better estimation can be obtained by expressing adsorption capacity as a power function of pressure rather than assuming a linear relationship between adsorption capacity and pressure while keeping other important parameters unchanged." **P.N.K. De Silva, P.G. Ranjith and S.K. Choi**, *Fuel*, Available online July 20, 2011, doi:10.1016/j.fuel.2011.07.010, http://www.sciencedirect.com/science/article/pii/S0016236111004078. (Subscription may be required.)

"Estimating the probability of CO_2 plumes encountering faults."

The following is the Abstract of this article: "One of the main concerns of CO_2 storage in saline aquifers is leakage via faults. In the early stages of site selection, site-specific fault (map) coverages are often not available for these saline aquifers. This lack of site-specific data motivates development of a method that makes use of available regional fault data to estimate the probability of injected CO_2 or the resulting pressure front encountering a fault, which is a necessary condition for leakage of CO_2 or brine to occur via these pathways. The probability of encounter can be calculated from areal fault density statistics generated from available data, and CO_2 plume or elevated pressure area dimensions generated by numerical simulation. Given a number of assumptions, the length of the plume or elevated pressure area perpendicular to a fault times the areal density of faults with offsets greater than some threshold of interest provides the probability of the plume or a pressure front of concern encountering such a fault. Application of this result to a previously planned, large-scale pilot injection in the southern portion of the San Joaquin Basin yielded a [three percent] and [seven percent] chance of the bulk phase CO_2 plume encountering a fully and half-seal offsetting fault, respectively. Subsequently available data provided a first test of this approach as a half-seal offsetting fault was discovered at a distance from the injection well that implied a 20 [percent] probability of encounter for a plume sufficiently large to reach it." **Preston D. Jordan, Curtis M. Oldenburg, and Jean-Philippe Nicot**, *Greenhouse Gases: Science and Technology*, Available online May 25, 2011, doi:10.1002/ghg.17, http://onlinelibrary.wiley.com/doi/10.1002/ghg.17/abstract. (Subscription may be required.)



TERRESTRIAL

"Modeling long-term soil carbon dynamics and sequestration potential in semi-arid agro-ecosystems."

The following is the Abstract of this article: "Long-term soil carbon (C) dynamics in agro-ecosystems is controlled by interactions of climate, soil and agronomic management. A modeling approach is a useful tool to understand the interactions, especially over long climatic sequences. In this paper, [the authors] examine the performance of the Agricultural Production Systems sIMulator (APSIM) to predict the long-term soil C dynamics under various agricultural practices at four semi-arid sites across the wheat-belt of eastern Australia. [The authors] further assessed the underlying factors that regulate soil C dynamics in the top 30 cm of soil through scenario analysis using the validated model. The results show that APSIM is able to predict aboveground biomass production and soil C dynamics at the study sites. Scenario analyses indicate that nitrogen (N) fertilization combined with residue retention (SR) has the potential to significantly slow or reverse the loss of C from agricultural soils. Optimal N fertilization (Nopt) and 100 [percent] SR, increased soil C by 13 [percent], 46 [percent], and 45 [percent] at Warra, Wagga Wagga and Tarelee, respectively. Continuous lucerne pasture was the most efficient strategy to accumulate soil C, resulting in increases of 49 [percent], 57 [percent] and 50 [percent] at Warra, Wagga Wagga and Tarlee, respectively. In contrast, soil C decreases regardless of agricultural practices as a result of cultivation of natural soils at the Brigalow site. Soil C input, proportional to the amount of retained residue, is a significant predictor of soil C change. At each site, water and nitrogen availability and their interaction, explain more than 59 [percent] of the variation in soil C. Across the four sites, mean air temperature has significant ($P < 0.05$) effects on soil C change. There was greater soil C loss at sites with higher temperature. [The authors'] simulations suggest that detailed information on agricultural practices, land use history and local environmental conditions must be explicitly specified to be able to make plausible predictions of the soil C balance in agro-ecosystems at different agro-ecological scales." **Zhongkui Luo, Enli Wang, Osbert J. Sun, Chris J. Smith, and Mervyn E.**

Terrestrial (Continued)

Probert, *Agricultural and Forest Meteorology*, Available online July 15, 2011, doi:10.1013/jagrformet.2011.06.011, http://www.sciencedirect.com/science/article/pii/S0168192311002048. (Subscription may be required.)

Trading

***Huffington Post*, "Australia Carbon Tax Plan Introduced By Julia Gillard,"** and ***Energy Daily*, "Australian Cabinet to Vote on Carbon Tax."**

The Australian Government plans to introduce a carbon price in Parliament next month, which would require Australia's 500 highest emitters to pay approximately $24 per ton of carbon emissions emitted beginning on July 1, 2012. The largest emitters would pay the fixed price per tonne of CO_2, which would allow emitters to buy offsetting shares from companies producing emissions less than target levels, until 2015, when a market-based trading scheme is expected to be introduced. The Australian Government would then designate a floor price and an upper limit for at least the first three years to avoid price fluctuations. Under the scheme scheduled to begin on July 1, 2012, the Australian Government plans to include any company that produces at least 25,000 tonnes of CO_2 per year. According to Australia's Prime Minister, the carbon tax plan would reduce emissions by five percent over 2000 levels by 2020 and would cut 159 million tons of carbon emissions. July 10, 2011, http://www.huffingtonpost.com/2011/07/10/australia-carbon-tax-plan_n_894016.html, and August 17, 2011, http://www.energy-daily.com/reports/Australian_Cabinet_to_vote_on_carbon_tax_999.html.

"Carbon trading: Current schemes and future developments."

The following is the Abstract of this article: "This paper looks at the GHG emissions trading schemes and examines the prospects of carbon trading. The first part of the paper gives an overview of several mandatory GHG trading schemes around the world. The second part focuses on the future trends in carbon trading. It argues that the emergence of new schemes, a gradual enlargement of the current ones, and willingness to link existing and planned schemes seem to point towards geographical, temporal and sectoral expansion of emissions trading. However, such expansion would need to overcome some considerable technical and non-technical obstacles. Linking of the current and emerging trading schemes requires not only considerable technical fixes and harmonization of different trading systems, but also necessitates clear regulatory and policy signals, continuing political support and a more stable economic environment. Currently, the latter factors are missing. The global economic turmoil and its repercussions for the carbon market, a lack of the international deal on climate change defining the Post-Kyoto commitments, and unfavorable policy shifts in some countries, cast serious doubts on the expansion of emissions trading and indicate that carbon trading enters an uncertain period." **Slobodan Perdan and Adisa Azapagic**, *Energy Policy*, Available August 4, 2011, doi:10.1016/j.enpol.2011.07.003, http://www.sciencedirect.com/science/article/pii/S030142151100526X. (Subscription may be required.)

Recent Publications

"The Costs of CO_2 Capture, Transport, and Storage."

The following is from the Executive Summary of this document: "Costs for different CO_2 capture, transport and storage options were first determined using data for the three main capture technologies (post-combustion, pre-combustion and oxyfuel) applied to hard coal, lignite and natural gas-fired power plants; the two main transport options (pipelines and ships); and the two main storage options (depleted oil and gas fields, and deep saline aquifers), both on- and offshore. The results were then combined in order to identify: (1) total costs for full-scale, commercial CCS projects in the [European Union (EU)] post 2020; (2) key trends and issues for various deployment scenarios; and (3) the impact of fuel prices, economies of scale and other factors (e.g. economic). Publicly available cost data on CCS are scarce. In order to obtain a reliable base for the estimations, it was therefore decided to use new, in-house data provided exclusively by [Zero Emission Fossil Fuel Power Plants (ZEP)] member organizations – 15 in total. This included five independent power companies and manufacturers of power plant equipment for CO_2 capture. In order to access the data, all basic cost information was kept confidential, regarding both source and individual numbers. To this end, one person per area was assigned to collect the information, align it, create mean values and render it anonymous. However, all contributors to the study, including those who provided detailed economic data, are named in Annex II. The ZEP cost study presents best current estimates for full-scale commercial CCS in the power sector in Europe post 2020, based on new, in-house data provided by member organizations. The final results assume that all elements of the value chain have been successfully demonstrated in the EU CCS demonstration program and other demonstration initiatives worldwide." The complete ZEP report is available for download at: http://www.zeroemissionsplatform.eu/library/publication/165-zep-cost-report-summary.html.

"Improving Domestic Energy Security and Lowering CO_2 Emissions with 'Next Generation' CO_2-Enhanced Oil Recovery (CO_2-EOR)."

The following is from the Executive Summary of this document: "This analysis, sponsored by U.S. DOE/NETL and prepared by Advanced Resources International (ARI), builds a national CO_2 EOR resource assessment from reservoir-to-reservoir simulations of CO_2 floods. ARI used a proprietary database that contains oil properties and geologic characteristics of 1,800 onshore reservoirs and over 4,000 off shore

Recent Publications (Continued)

sands. The simulations were conducted using the PROPHET model. PROPHET, originally developed by Texaco for DOE in the 1980s, models stream tubes of fluid flow between injection wells and producing wells. PROPHET is a screening tool and estimates the magnitude and timing of oil production based on a user-defined CO_2 injection protocol and the porosity of the host rock, the thickness of the oil, the degree of fracturing and discontinuity within the target formation and other inputs. NETL published a similar resource assessment in February 2010; this report supersedes the earlier assessment. For this analysis, the simulation methodology was peer reviewed by industry practitioners and important refinements were made based on their input. Aggregated results indicate that CO_2-EOR can provide high value benefits to the domestic economy and the environment, as discussed below." This NETL-published document is available at: http://www.netl.doe.gov/energy-analyses/pubs/NextGen_CO2_EOR_06142011.pdf.

"Underground Storage of CO_2: Extensive Research and Operating Experience Show It Can Be Done Safely."
The following is an excerpt from this document: "Storing CO_2 in deep underground rock formations is not a new idea. Large underground reservoirs of CO_2 occur naturally, and have existed for millions of years. Permanently storing CO_2 that has been captured from above-ground industrial projects returns the CO_2 to deep, secure, underground rock formations. The CO_2 is stored at geological depths of 1 to 5 kilometers whereas drinking water is found only a couple of hundred meters below the surface, thus ensuring the safety of groundwater. Proper storage site selection, a barrier of impermeable caprock above the CO_2, and natural trapping mechanisms ensure that CO_2 will remain permanently stored." This Integrated CO_2 Network (ICO_2N) publication can be viewed at: http://www.ico2n.com/wp-content/uploads/2010/07/Carbon-Storage-Backgrounder2.pdf.

Legislative Activity

***Illinois Governor Pat Quinn Press Release*, "Governor Quinn Signs Law to Advance Clean Energy Project in Southern Illinois."**

On August 2, 2011, the Governor of Illinois signed Senate Bill 2169 to provide the framework for Power Holdings, LLC, to build a $2.3 billion facility that will convert coal to synthesis natural gas (SNG) in Jefferson County. The legislation, which immediately took effect, includes consumer protections like a rate cap and an account to pass savings back to consumers. Power Holdings will also be required to share its construction and carbon storage costs, as well as operating expenses, to state regulators through annual reports and plant reviews. Power Holdings has already obtained an active air quality permit from the Illinois Environmental Protection Agency for its gasification technology to capture emissions and safely store more than 90 percent of the plant's CO_2 emissions. Power Holdings expects to generate more than $10 billion in economic activity and create more than 1,650 jobs, including approximately 1,100 construction jobs, 300 permanent mining jobs, and 250 permanent plant jobs. Senate Bill 2169 can be viewed at: http://www.ilga.gov/legislation/97/SB/PDF/09700SB2169lv.pdf. August 2, 2011, http://www.illinois.gov/PressReleases/ShowPressRelease.cfm?SubjectID=3&RecNum=9595.

Events

September 12-15, 2011, **2011 International Pittsburgh Coal Conference**, *David L. Lawrence Convention Center, Pittsburgh, Pennsylvania, USA*. This conference will feature technical and business discussions about major clean coal technology demonstration projects. In addition, three business sessions are offered that cover financing CCS and other clean coal technologies, investing in energy and power, and insurance and risk management strategies. For more information, go to: http://www.engr.pitt.edu/pcc/.

October 9-11, 2011, **Reservoir Characterization and Simulation Conference and Exhibition**, *Beach Rotana Hotel, Abu Dhabi, UAE*. SPE is hosting the third edition of the Reservoir Characterization and Simulation Conference and Exhibition (RCSC), focusing on reservoir applications and different technologies for characterizing, modeling, and simulating reservoir characteristics. To learn more, visit: http://www.spe.org/events/rcsc/2011/.

October 9-14, 2011, **CO_2 Storage: Will we be ready in time?**, *The Algarve, Portugal*. This forum, designed for professionals in the oil and gas, power, and alternative energy industries who focus on CCS schemes, will address the opportunities and challenges related to the development of CO_2 geologic storage activities that would be several orders of magnitude larger than current demonstration projects. For more information, visit: http://www.spe.org/events/11fse3/pages/about/index.php.

Events (Continued)

October 19-20, 2011, **Carbon Capture and Storage – The Leading Edge**, *London, United Kingdom*. This Institution of Mechanical Engineers seminar will discuss carbon capture technology and the implications across the regulatory, financial, and process technology fields. The following areas will also be covered: properties of CO_2, European Union competition, and front-end engineering design (FEED) case studies. Seminar details are located at: http://events.imeche.org/EventLocation.aspx?EventID=1204.

October 20-21, 2011, **The Carbon Show 2011**, *Business Design Center, London, England*. This conference offers a program dedicated to the following topics: climate finance, CRC energy efficiency scheme, carbon management, and green technology and renewables. Industry experts will share best practices and offer attendees the opportunity to debate and discuss carbon and carbon market developments. Conference details are available at: http://www.thecarbonshow.com.

November 15-16, 2011, **Low-Carbon Energy Technologies: Innovations in Efficiency and Greenhouse Gas Reduction Science and Technology Seminar**, *Southwest Research Institute, San Antonio, Texas, USA*. This seminar will focus on alternative energy technologies, carbon reduction through improvements in efficiency, and carbon conversion and storage. Topics include: efficiency improvements to reduce carbon footprint, alternative power (wind, solar, and energy storage), low-carbon emission power plant cycles, CO_2 compression and storage, and CO_2 conversion and utilization. For more information, go to: http://www.swri.org/mailer/Div18/2011/IndLectureFlyr-4.pdf.

November 15-17, 2011, **DOE's Carbon Storage Program Infrastructure Annual Review Meeting**, *Sheraton Station Square, Pittsburgh, Pennsylvania, USA*. This meeting highlights DOE's carbon storage infrastructure projects, which include the efforts of DOE's RCSPs; however, it is now expanding to include other U.S. and international projects that are working to characterize storage capacity through exploration and injection operations. For more information, go to: http://www.netl.doe.gov/events/.

December 13-15, 2011, **POWER-GEN International 2011**, *Las Vegas Convention Center, Las Vegas, Nevada, USA*. POWER-GEN International is the industry leader in providing comprehensive coverage of trends, technologies, and issues facing the generation sector. This year's program consists of a variety of tracks, including: industry trends, power generation, environmental issues, fossil technologies, gas turbine technologies, renewable energy, on-site power, and plant performance. Conference details are available at: http://www.power-gen.com.

February 7-9, 2012, **Carbon Management Technology Conference**, *Caribe Royale Hotel & Convention Center, Orlando, Florida, USA*. This inaugural conference draws professionals from all engineering disciplines to share their expertise on the reduction of GHG emissions and adaptation to changing climate. The conference will focus on engineering perspectives regarding key issues, including technologies, strategies, policies, and management systems. More information is located at: http://www.spe.org/events/cmtc/2012/index.php.

November 18-22, 2012, **International Conference on Greenhouse Gas Technologies 11 (GHGT-11)**, *Kyoto International Conference Center, Japan*. This will be the second visit to Kyoto by the GHGT conference series, with more than 1,600 delegates expected to attend. A formal agenda has not yet been developed; however, planning for GHGT-11 is underway, with a call for papers expected to open toward the end of September 2011. Visit: http://www.ghgt.info/index.php/Content-GHGT11/ghgt-11-overview.html for more details.

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To learn more about DOE's Carbon Sequestration Program, please contact John Litynski at john.litynski@netl.doe.gov, or Dawn Deel at dawn.deel@netl.doe.gov.